was eleven syllables a second; and, indeed, at this speed all the syllables were not perfectly articulated.

This experiment has no particular interest in itself, for it only confirms the results of Schäfer, Lovèn and Griffiths, that repeated voluntary muscular actions have a speed of some ten or twelve per second. But, if we modify it slightly, its bearings are much wider. If instead of *vocally* articulating the syllables, we *think* them and articulate them only *mentally*, we exclude muscular action from any share in the process, and the rapidity of the mental articulation will be the index of the cerebral rhythm, not the muscular. Well, I found, as any of you can do with the help of a good seconds watch, that the mental articulation gives exactly the same figure as the vocal; that is, ten or eleven syllables per second.

We come to the interesting and relatively unforeseen conclusion that the cerebral phenomena of feeling (in the retina), volition (on the muscles), and thought (in mental articulation) cannot be repeated faster than twelve per second, and that they last about one-eleventh, or in round numbers one-tenth, of a second; the isolated sensation, the isolated act of will, the isolated intellectual process, have all the same minimum duration.

Placing this result next to our determination of the period of the nerve-wave, we conclude that there is here more than a mere coincidence; it is an *à posteriori* proof of our hypothesis as to the period of the nerve-wave.

From the psychological point of view this leads us to very important deductions. Of course we can conceive the second to be divided into hundredths, millionths, billionths; but these divisions have no relation to our direct consciousness. Our consciousness can only perceive much longer intervals. Our cerebral organisation determines narrow limits for our appreciation of time. We may therefore define the *psychological unit of time*, the irreducible unit, as *that minimum duration of time which is appreciable to our intelligence.* This is, indeed, susceptible of further theoretical subdivision; but such subdivisions correspond to no real mental image.

We may say, in other words, that the minimum time which our consciousness can directly apprehend is, in round numbers, one-tenth of a second.

"Swift as thought" is an everyday phrase; but you see thought is not very swift, after all, if we compare it to the enormous frequency of the vibrations of light and electricity.

Sir William Crookes, one of your most illustrious presidents, spoke of the relativity of our knowledge in his recent address; he alluded to the cruel imperfections of our animal nature. For us there exists no time-interval shorter than one-tenth of a second; and yet during this short interval, within which our gross intellectual apparatus cannot penetrate, who knows what sequences of phenomena may go on, which we could perceive if our nervous system had a shorter period of vibration? Then would phenomena which we perceive as continuous reveal their true character of discontinuity; those molecular vibrations which to us do not appear as vibrations would take on their real aspects. In a word, our time-unit, which is so different from the units of many phenomena of matter, makes us live in one perpetual illusion.

One more point I wish to touch upon is interesting in many respects. Let us come back to the diagram I gave you above to show the mode of damping of the nerve-wave. I told you that the original level is never regained when the system is damped to a position of rest; it approaches the level indefinitely but never reaches it. Practically speaking, equilibrium is reached at the end of the tenth of a second; physically and physiologically speaking, everything is set in order; the nerve-wave is ended, and the return to equilibrium is total. But if we deal with infinitesimal quantities this return is not complete; so that if we imagine an apparatus capable of appreciating infinitesimal quantities, it would show that, as the mathematical theory predicts, the return to equilibrium is never complete or absolute.

Well! we may fairly suppose that consciousness is alive to this infinitely small quantity, and that the impossibility of the complete return to the primitive equilibrium accounts for the strange phenomenon, unknown in the inorganic world, which we call *Memory*.

After a nerve-wave, the neuron is no longer in the same state as before; it retains the memory of the wave, and this makes it now other than what it was. I pronounce the vowel "A"; one-tenth of a second later I can pronounce some other vowel, for my nervous system has returned to equilibrium; but this return, however, is not complete, for the memory of the "A" which I pronounced persists, and will persist indefinitely. The primitive condition will never recur, whatever happens. In time the memory of the vowel "A" will gradually fade, but it will never be effaced. A nerve-wave of the brain is never completely extinguished.

The fact is that we are here on the confines of two totally distinct worlds: the world of physics and the world of psychology. What is infinitesimally small in the physical world may possibly be infinitely great in the psychological world. The residues of nerve-waves, the asymptotic prolongations of curves, may be neglected by the physiologist and the physicist; they are not negligible to consciousness.

Consciousness distinguishes them from the strong vibrations actually going on, which it recognises as "the present"; but the waves that are passed still exist for consciousness, never perhaps to be annihilated.

Assuredly this is but an hypothesis, perhaps an analogy, a comparison, rather than an hypothesis; but it is none the less interesting to note how far the physiological theory of the damping of the nerve-wave is in agreement with the grand psychological fact of memory, which it is scarcely possible to explain in any other way.

IX.

Thus the nerve-wave in its form and period, and in the mode of its damping, is comparable with the various waves of the unbounded universe in which we live, move and have our being. But this resemblance must not lead us away from the recognition of the abyss that separates the nerve-wave from all the other phenomena within our reach. The vibrations of the forces scattered about us are—at least with the greatest probability—blind phenomena, which know not themselves, which are the slaves of irresistible fatality. The nerve-wave, on the contrary, knows and judges itself; it is self-knowing or self-conscious; it can distinguish itself from the world which surrounds it and shakes it.

Since it possesses intelligence—for intelligence and consciousness are synonymous terms—it is susceptible of perfectibility; it is capable of right reasoning and of wrong reasoning; it can attain a moral ideal forbidden to those brute forces which follow their fated course; it can conceive the idea of truth and justice when it is a question of defending the innocent, of establishing brotherhood among men.

Consciousness, intelligence, the making for higher perfection—these are characters that have nought in common with the characters of other waves; they seem to be phenomena of another, a higher order. This vibration, whose physical conditions we have studied, enters into the domain of morals; and this fact establishes its essential difference from all other vibrations.

Assuredly the prodigiously rapid and regular undulations of light, and of electricity, appeal right justly to our admiration; but nothing is so admirable as this disturbance of the nerve-cell, which is self-knowing, self-judging, self-transforming, which strives to amend itself, and which from the stimuli which strike it can deduce some of the laws ruling the vast universe distinct from it. The nerve-wave of man—himself the last result of evolution—is the most perfect term of the things and of the beings which it is given to us to know.

Vast as is the world, mighty as are the fires of the infinite stars, the intelligence of man is of a higher order than these; and I would fain exclaim with the great philosopher, Immanuel Kant: "More than the starry heaven above my head, one thing fills me with admiration: the moral law in the heart of man."

ZOOLOGY AT THE BRITISH ASSOCIATION.

ON the opening day (Thursday) only the President's address was taken, and the Section then adjourned with the object of hearing addresses in other Sections which were of biological interest. The total number of papers brought before the Section this year was not as large as usual, but they extended over a wide range of zoological subject-matter, as the following outline programme shows:—

Friday morning, morphological papers; Friday afternoon, papers on entomology and mimicry; Saturday, marine biology; Monday, morphology, &c.; Tuesday, papers on sea-fishery questions. The usual reports upon investigations in progress were also submitted.

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The morphological papers on Friday were as follows :—

(1) J. J. Lister, on *Astrosclera willeyana*, the type of a new family of calcareous sponges. This remarkable new sponge was brought home by Dr. A. Willey from Lifu in the Loyalty Islands. It has a continuous calcareous skeleton formed by the union of numerous polyhedral spicules to form a branched mass, between which run the soft parts with the system of canals. There are very minute ciliated chambers, and the ciliated cells do not appear to have the usual collars.

(2) Prof. Johnson Symington, on the morphology of the cartilages of the monotreme larynx. The thyroid cartilage of the monotremes (*Ornithorhynchus* and *Echidna*) agrees with that of the higher mammals in consisting of a single cartilaginous mass, but differs in the details and relations of its anterior and posterior cornua. Both the ontogeny and the phylogeny of the mammalian epiglottis support the view that it is a single median structure, and not, as Gegenbaur supposed, the result of fusion of two lateral elements.

(3) N. Bishop Harman, the palpebral and oculo-motor apparatus in fishes. Seventy species of fishes were examined. The simplicity or complexity were not found to agree with differentiation in phylogeny, nor with any scheme of classification, nor in relation to habitat. The source of the complex musculature of the eyelids of Selachians was traced to the branchial musculature of the spiracle, and this was further shown by the inverse ratio existing between the condition of spiracle and nictitating membrane. In those fish in which the latter is at its highest development the spiracle is absent, and *vice versâ*. The condition of the orbital sac, of the supporting rod of cartilage, of the eye-muscles, and of other neighbouring structures in the eyes of various groups of fishes was discussed.

(4) Prof. R. J. Anderson, on the pelvic symphysial bone of the Indian elephant ; and a few notes on rhythmic motion.

(5) C. Dawson and S. A. Woodhead, on the crystallisation of beeswax, and its influence on the formation of the cells of bees.

On Saturday, when some of the zoologists from the French Association visited the Section, a few papers on marine biology likely to prove interesting for joint discussion were taken. Mr. W. Garstang brought forward a first report on the periodic investigation of the plankton and physical conditions of the English Channel during 1899. These investigations have been carried out at regular quarterly intervals during the year, from a steam-tug ; and the observations were made at certain fixed localities along lines between Plymouth and Ushant, from Ushant towards the 100 fms. line, and off the entrance to the Channel. Observations of the water temperature (with deep-sea reversing thermometers) at various depths, and of the salinity (with Mill's water-bottle) of the water were taken ; and collections of plankton were made with an effective closing tow-net specially devised by Mr. Garstang to replace the pump and hose method, which had proved unsatisfactory. This new net, and also that of Dr. C. G. J. Peterson for the quantitative estimation of plankton, were on exhibition and with the rest of the apparatus were shown working. Mr. Garstang's investigations in the Channel are not yet completed, and two further series of observations are still to be made. The record so obtained will be of high value in both marine biological and hydrographical inquiry. Prof. Lankester and others took part in the discussion, and one of the visitors, Baron Jules de Guerne, explained the somewhat similar observations he had been making from the Prince of Monaco's yacht *Princesse Alice*, and described the closing nets he employed. The reports upon the Naples and Plymouth biological stations were also submitted.

On Monday the following papers were taken :—

(1) J. Graham Kerr, the development of *Lepidosiren paradoxa ;* and a note on the hypothesis of the origin of the vertebrate paired limbs. Mr. Kerr had been sent by the University of Cambridge with an expedition in search of *Lepidosiren* to the rivers and swamps of Gran Chaco in Paraguay ; and he gave an interesting summary of the life-history of this important type.

(2) Dr. J. F. Gemmill, on negative evidence regarding the influence of nutrition in determining sex. Dr. Gemmill shows that certain fixed species of marine animals are under very different conditions of nutrition from the very earliest period, according as they are high or low on the shore, and yet the proportions of the sexes remain unchanged—indicating that in such forms nutrition has no effect in determining sex.

(3) F. P. Morena and A. Smith Woodhead, exhibition of and remarks on a skull of the extinct Chelonian *Miolania* from Patagonia, along with an exhibition of newly-discovered *Neomylodon* remains from Patagonia—a most interesting and important exhibit of these remarkable remains.

(4) G. E. H. Barrett-Hamilton, the fur seals of the Bering Sea. An account of their habits and condition.

The rest of the afternoon was occupied with reports of Committees, which will be noticed below.

On Tuesday, Sir John Murray read a paper on Dr. Peterson's experiments in the Cattegat, with the marking and measuring of plaice in order to determine distribution and growth, and on plaice culture in the Limfjord. By transplanting young fish from the North Sea into the richer feeding grounds of the shallow fjord, it was found that from April to November they increased to five times their original weight. The cost of transportation was one-sixth of a penny per fish, and the price obtained for a fish so fattened was 4*d.*—a notably successful attempt at economic fish culture.

Mr. W. Garstang gave an account of his experiments at Plymouth on the artificial rearing of young sea-fish. In this Mr. Garstang has, so far, been very successful ; and has succeeded in rearing about 50 per cent. of his larvæ through their critical stages to the complete adult organisation. They are fed on plankton, and are kept in "plunger" jars with not more than five larvæ to a gallon of water.

Dr. James Murie gave an account of the Thames Estuary : its physico-biological aspects as bearing upon its fisheries. These papers gave rise to some discussion on marine fish-culture.

Prof. McIntosh, finally, gave a paper on the occurrence of the grey gurnard (*Trigla gurnardus*, L.), and its spawning in inshore and offshore waters. He shows by a monthly examination of the statistics that this important fish does not begin to move into the inshore waters for spawning purposes until after February, and attains its maximum in May. He does not consider that a maximum as late as August in some years can be taken to indicate a second spawning migration, as supposed by the Scottish Fishery Board. Spawning goes on from April to September.

The Reports of Committees submitted to the Section were as follows :—

(1) The Naples Zoological Station.—The British Association table has been occupied by Dr. H. Lyster Jameson, who gives a summary of his work upon the anatomy of certain Gephyrea and allied vermiform organisms. The usual statistics and other information in regard to the station during the year are also given.

(2) Investigations at the Plymouth Marine Laboratory.—This contains two short papers, one on the embryology of the Polyzoa, by T. H. Taylor, and the other on the rearing of larvæ of Echinidæ, by Prof. MacBride. Mr. Taylor's observations were made on the larvæ of *Bowerbankia*, which he successfully carried through their fixation and metamorphosis on strips of celloidin. MacBride found at Plymouth that the larvæ of Echinids would only live in pure water brought from outside the breakwater. He discusses the difficulties, and the conditions necessary for successful rearing of larvæ.

(3) Zoology and Botany of the West India Islands.—This is the final report, and consists of a list of the publications of the Committee. The material which still remains unworked out has been presented to the British Museum.

(4) Zoology of the Sandwich Islands.—This ninth report shows what has been published by the Committee during the year, and gives the plans for further exploration in the Islands in conjunction with the Honolulu Museum.

(5) Bird Migration in Great Britain and Ireland.—The labour of working out the numerous records obtained from lighthouse-keepers is still being continued by Mr. Eagle Clarke, and a conclusive report is not yet possible.

(6) Zoological and Botanical Publication.—The Secretary of the Committee is in correspondence with editors of academical and periodical publications, and the results will be reported on at a future meeting.

(7) Index animalium.—This great piece of work is still being carried on by Mr. Sherborn, who has indexed about 1500 volumes during the last year. The first section of the Index, dealing with 1758–1800, will soon be ready for publication.

(8) Pedigree Stock Records.—This report is drawn up by Dr. Francis Galton, and deals with the production of photographs, under standard conditions, of prize-winners at shows of pedigree stock, in order to have exact trustworthy records of ancestry.

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(9) A circulatory apparatus for experimental observations on marine organisms.—The work has been carried out by Mr. F. W. Gamble at the Piel Sea-Fish Hatchery on the Lancashire coast; and the observations chiefly dealt with the changes in colour, and the mechanism of colour physiology in the Crustacean *Hippolyte varians*.

On one of the afternoons Mr. J. W. Woodall took a small party of zoologists to sea in his yacht *Vallota*, to witness the trial of Mr. Garstang's new tow net, which can be opened and closed in any depth of water. In addition to the actual proceedings in Section D, it may be noted that there was a good deal in several of the other Sections that was of zoological interest.

THE SEVENTH INTERNATIONAL GEOGRAPHICAL CONGRESS.

AT the close of the Sixth International Geographical Congress in London in 1895 it was decided that the next meeting should be held in Berlin in 1899, under the auspices of the Berlin Geographical Society. This meeting, with its attendant festivities, has just been concluded. Although the actual sittings of the Congress extended only from September 28 to October 4, the proceedings began a week earlier and were continued more than a week later, by a series of geographical excursions to different parts of the German Empire. Taken as a whole the Congress must be pronounced not only successful, but brilliantly so; it presents a sort of climax in respect of grandeur to the preceding meetings, and suggests that the time has now come for reconsidering the general plan of such gatherings, and starting afresh on lines of plainer living, if not of higher thinking. Here, however, we have only to sketch the work of the Congress just over, not to suggest the plan of its successor.

The Council of the Berlin Geographical Society had the entire charge of the organisation, and by the usage of previous meetings the President of the Society, Baron Ferdinand von Richthofen, professor of Geography in the University of Berlin, was President of the Congress. The personal efforts of Baron Richthofen were unceasing before and during the meeting, and as no German geographer is better known or more widely respected at home and abroad, the accident of his presidency of the Society was singularly fortunate for the success and *éclat* of the Congress. He was supported as secretary by Hauptmann Georg Kollm, and a number of younger geographers who formed a staff of efficient assistant secretaries, but whose names were not brought before the members. Similarly, the various honorary officials—vice-presidents, members of committees, &c., whose names had appeared in circulars sent out some months before the meeting—remained unknown to most of the members, who had left their early circulars at home. There were general programmes, printed in German, English and French, detailing the work for each day, and a supplementary programme of entertainments in German only, with additions and alterations to the list of papers; but there was no daily journal giving a clear view of the work of each day, with the names of presiding officers and a summary of the work of the day before, as at the London Congress. German also was the one language used in the general business, all announcements were made in German only, almost all the notices exhibited were in German and sometimes even in the German script, which can scarcely be looked on as an international character. In London the three languages were used for every written or printed notice and every important verbal announcement. The abstracts of papers, which were circulated daily, were printed in the language of the author only. The foreigner, unversed in the German language and unused to German customs, was somewhat at a disadvantage throughout, both in scientific meetings and at social functions.

These minor matters apart, the organisation left nothing to desire. The grand building of the Prussian Chamber of Deputies, generously lent to the Congress by the Prussian Government, formed a perfect home for the member. A "depositorium," bearing the number of his ticket, received all communications intended for him, an admirably-conducted cloak-room relieved him of hat and coat, and restored them with a swiftness and certainty that seemed magical to the frequenter of British scientific gatherings; a vast refreshment room could serve breakfast, lunch and supper to the whole Congress simultaneously; picture post-cards (more essential than food to the German visitor) were on sale in every room, even in the Great Hall while papers were being read; desks were provided for issuing tickets, badges and the many offerings of books, maps, &c., presented by institutions and firms; while the luxurious reading- and writing-rooms of the Prussian Deputies were thrown open absolutely without reserve. As an example of international hospitality, the installation of the Congress was memorable and unique. Perhaps the best managed of all the hospitable arrangements was the Ladies' Committee, specially charged with the care of the lady associates of the Congress, which carried out its work with most satisfactory diligence and completeness.

The Congress commenced informally in true German style by the members dropping in as they arrived on the evening of Wednesday, September 27, to the restaurant of the House of Deputies, where they sat at supper or wandered through the various halls, greeting old friends and forming new acquaintances. Next morning at ten o'clock the formal opening took place with much dignity, the gentlemen appearing in evening dress or uniform with a profuse display of orders. Prince Albrecht of Prussia welcomed the Congress in the name of the Emperor; Prince Hohenlohe, the Imperial Chancellor, welcomed it in the name of the Empire; Herr Studt, the new Prussian Minister of Education, in the name of the kingdom of Prussia, the speeches of these great personages being received in solemn silence. The Burgermeister of Berlin then welcomed the members in the name of the city, and applause, which was not stinted to subsequent speakers, then began. The welcome was responded to by a few of the most distinguished foreigners. Baron Richthofen read his presidential address, on the progress of geography in the nineteenth century; Sir Clements Markham, as president of the sixth Congress, gave a short address, resigning his office and presenting the report of the London Congress. Vice-presidents and chairmen of the different sections were nominated, and the formalities were over.

It is unnecessary to detail the social accompaniments of the Congress. The Imperial Chancellor gave a small dinner and a large reception to the foreigners and the more prominent German members. The city of Berlin gave an admirably conducted dinner to the whole Congress in the Zoological Gardens. The Berlin Geographical Society also entertained all the members to a reception and supper, and there was a special performance in the Opera House.

It is impossible to pass without remark the magnificent hospitality of Hamburg, where over 500 members of the Congress were received by the local Geographical Society, and carried through two days of uninterrupted festivity. The Senate opened the State rooms of the new Town Hall, probably the finest municipal building in the world, for the first time in honour of the visitors, and an even more impressive view of the vast wealth and activity of the greatest continental seaport was afforded by a cruise through the harbour and a visit to the floating docks and ship-building works. The Hamburg-America Line entertained a thousand guests to lunch in the "'tween-decks" of the *Pretoria*, said to be the largest cargo steamer afloat, and this on the day before she sailed for New York with a full cargo and complement of passengers. No less hearty and no less interesting were the receptions accorded to the members of the various excursions to the Baltic shores, the Rhine and Central Germany by the local authorities and geographical societies.

The serious business of the Congress was divided into a general meeting in the forenoon from ten to one, and three simultaneous meetings in the afternoon, commencing at two o'clock, and sitting until five or even six. A time-limit for speakers was formally announced, but rarely, if ever, enforced; and the system of allowing one speaker to address the meeting as often as he liked on the same subject led to the degeneration of some of the debates into long-winded dialogues.

The programme with its additions bore the titles of no less than 150 papers, many of which were intended to be introductory to discussions. This number might have been reduced with great advantage. A few were the work of "cranks," a good many were old or of no international interest; but the great majority were new and valuable and deserving of far more complete discussion than their number made it possible for them to receive.

The departments of Geography which received most attention at the Congress were, perhaps, Antarctic Exploration, Oceano-

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